National High Magnetic Field Laboratory
Pulsed Field Facility - LANL

NHMFL-Los Alamos Team • www.lanl.gov/mst/nhmfl

The National High Magnetic Field Laboratory (NHMFL) is a consortium of three institutions, Florida State University, Los Alamos National Laboratory and the University of Florida, jointly funded by the National Science Foundation, the State of Florida and the US Department of Energy. The Los Alamos National Laboratory (LANL) is the home of the Pulsed Field Facility of the NHMFL. The NHMFL laboratories are the only facilities in the US (among a few worldwide) to host qualified users while running strong in-house science programs related to high magnetic field research. At Los Alamos, the NHMFL advances the frontiers of condensed matter physics at extreme conditions of high magnetic field, low temperature and pressure, utilizing start-of-the-art pulsed magnets and unique experimental capabilities.

The NHMFL's mission is to maintain a strong in-house research program in condensed matter physics in conjunction with an international users program that takes advantage of its unique pulsed magnets and experimental capabilities. The Laboratory is staffed with world-renowned scientists in condensed matter physics in pulsed magnetic fields driving their own research programs and hosting qualified users.

Figure 1: Summary of Scientific Capabilities at the NHMFL Pulsed Field Facility

Field, Duration, Bore	Supported Research
Capacitor-bank-driven magnets Cell#1: 50 T–Short Pulse, 25 msec, 24 mm Cell#2: 40 T–Mid-Pulse, 400 msec, 24 mm Cell#2: 50 T–Mid-Pulse, 400 msec, 15 mm Cell#3: 60 T–Short Pulse, 25 msec, 15 mm Cell#4: 60 T–Short Pulse, 25 msec, 15 mm	Magneto-optics (IR through UV), magnetization, and magneto-transport from 350 mK to 300 K Dilution refrigerator with 50 T, 24 mm Pressure from 10 kbar typical, up to100 kbar 60 T – Long Pulse Magnet *to return to service in 3rd quarter 2004. See the Magnet Science and Technology section for details.*
Superconducting magnets 20 T magnet, 52 mm 15 T magnet, 52 mm 14 T-PPMS magnet	Same as pulsed fields, plus thermal-expansion, specific heat, and 20 mK to 600 K temperatures Heat Capacity Resistivity

The NHMFL-Pulsed Field Facility research staff and collaborators have developed a wide variety of experimental capabilities utilizing the short pulse and superconducting magnets, which are summarized in the table to the left. Research proposals to use the facility are submitted through the laboratory's webpage.

100T dewar inside new magnet pit

The NHMFL Large Magnet Program is busy rebuilding the 60T-Long Pulse magnet, which will be completed in late 2004. Construction has also begun on the non-destructive 100T-Multi Shot magnet, which will be able to deliver around 6 full field shots each day.

Renovated magnet pits for 100T-MS and 60T-LP

New capacitor bank for the 100T Multi-shot

Recently, LANL - LDRD Program funded a 300T single turn magnet project through. The principle objective of the project is to unravel the puzzling electronic properties of plutonium with a state-of-the-art phase sensitive GHz detection system. 300T fields are expected to be available in the 4th quarter of 2004.

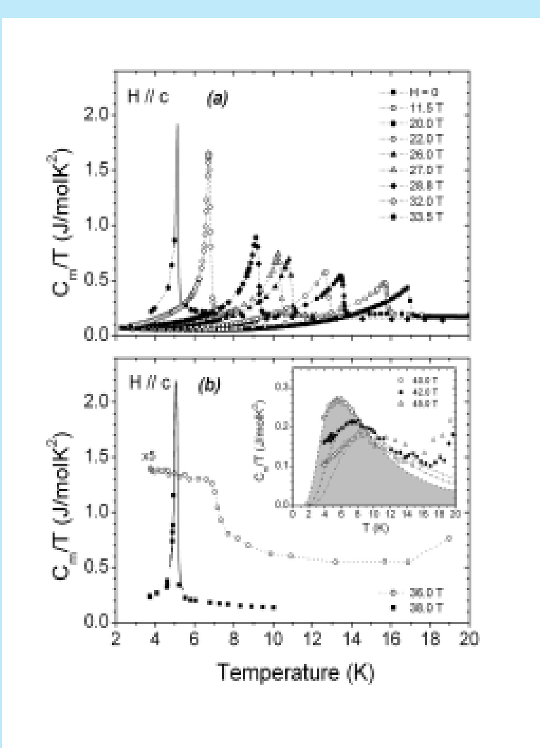

Figure 1: (a) C_m/T vs T measured at constant magnetic fields up to 33.5 T. Symbols correspond to thermal relaxation method, solid lines to large delta T method [12], and dotted lines are guides to the eye. (b) C_m/T vs T for H = 36 and 38 T. Inset: C_m/T vs T for H = 40, 42 and 45 T. Dashed lines are fits with a Schottky expression.

High magnetic field studies of the hidden order transition in URu2Si2
*M. Jaime et al. Physical Review Letters **89** (2002) 287201*

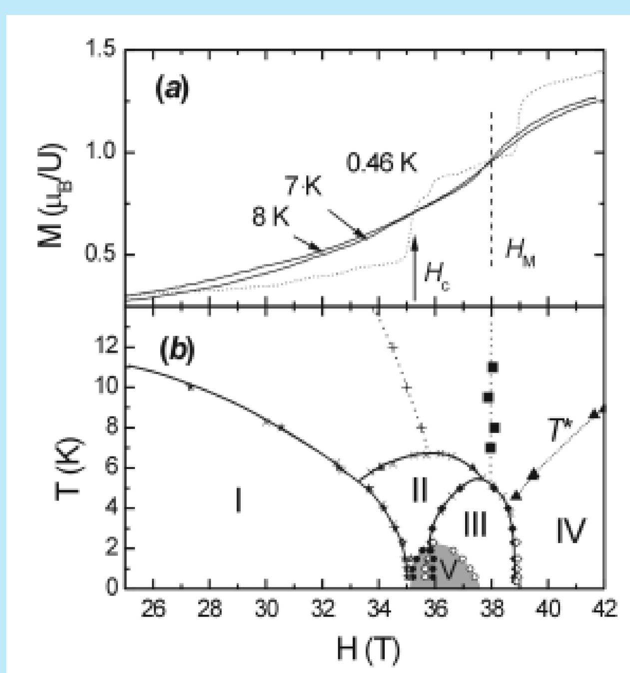

Figure 2: (a) Magnetization vs field measured in a pulsed magnet at constant temperature. (b) (H,T) Phase diagram constructed from specific heat, resistivity and magnetization data. At higher temperatures + symbols indicate a maximum in the r(H) curves, solid squares are the position of the metamagnetic transition in M(H) curves, and solid triangles in the 40 T region indicate crossover from T^2 to T in r(T) curves. All these three line seem to converve at a hypotetical quantum critical point at H = 38 T at T = 0 K. Quantum fluctuations in the proximity of the QCP seem to generate competing field-induced phases.6:

Reentrant Hidden Order at a Metamagnetic Quantum Critical Endpoint
N. Harrison et al., Physical Review Letters, 90 (2003) 096402

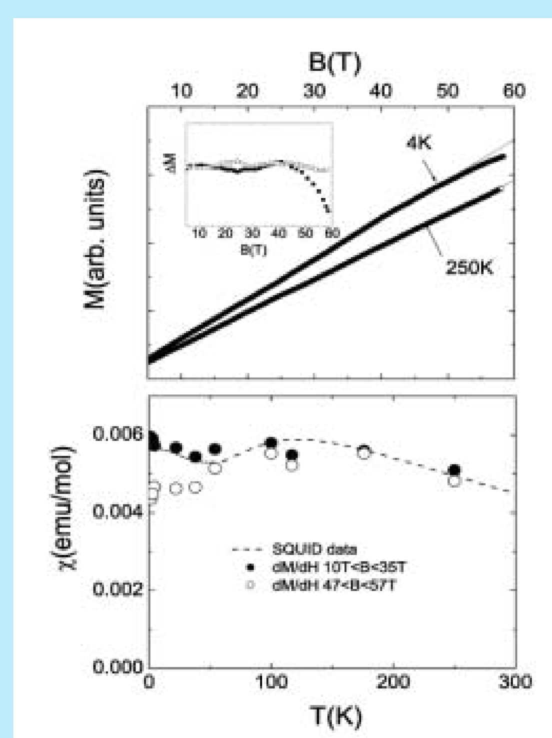

Figure 3: (a) Magnetization versus magnetic field at 4K and 250K; the solid lines are linear fits to the data in the range 10T < B < 35T. Insert: The difference DM between the data and the linear fits. (b) Susceptibility c(T) measured at both low (10T < B < 35T) and high (47T < B < 57T) magnetic field. The dashed line is data taken at 1T.

Two Energy Scales and Slow Crossover in $YbAl_3$
*Cornelius et al., Physical Review Letters **88** (2002) 117201*

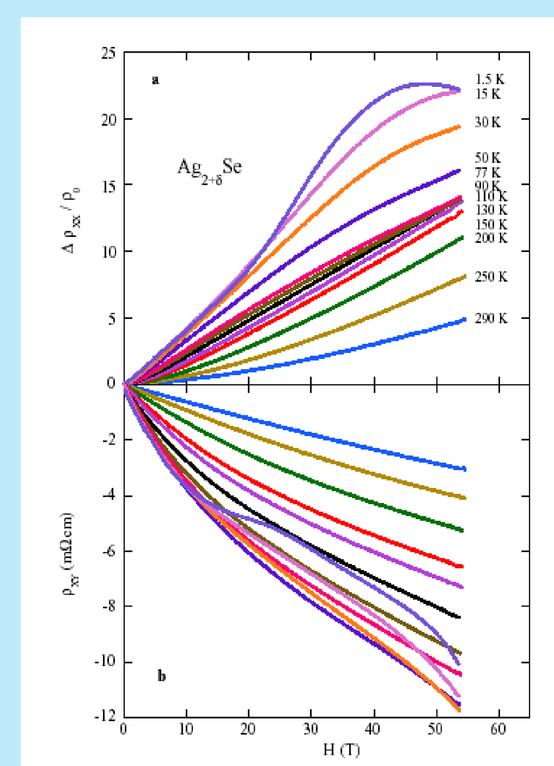

Figure 4: Magnetotransport of $Ag_{2+\delta}Se$ with $\delta \sim 10^{-4}$ in a 55 Tesla pulsed magnetic field. (a) The magnetoresistance normalized to its H = 0 value continues to climb over the full extent of the magnetic pulse at all temperatures T. (b) Field variation of the Hall resistivity at the same temperatures (color coded). In the low T, low H limit, electron density n = 1.1 x 10^{18} cm^{-3}.

Megagauss Sensors
*A. Husmann et al., Nature **417** (2002) 421*

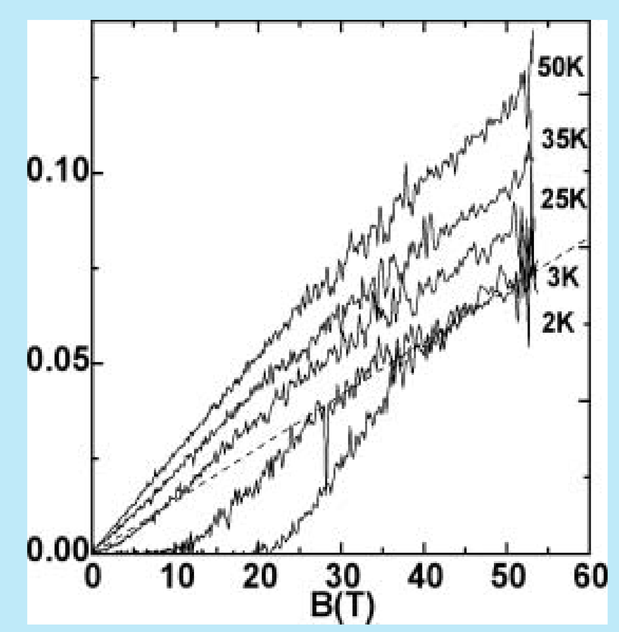

Figure 5: Magnetic field dependence of Hall resistivity in $Bi_2Sr_{2.49}La_{0.51}CuO_{6+\delta}$ sample (T_c=26K) at temperatures above and below T_c. The dashed line is a best linear fit, $\rho_{xy}(H)= R_H H$, for a high field regime for T=2K trace.

Low Low-Temperature Normal-State Hall Effect in High-T_c $Bi_2Sr_{2-x}La_xCuO_{6+}$ Revealed by 60T Magnetic Fields
F. F. Balakirev et al. PPHMF-4, World Scientific 2002

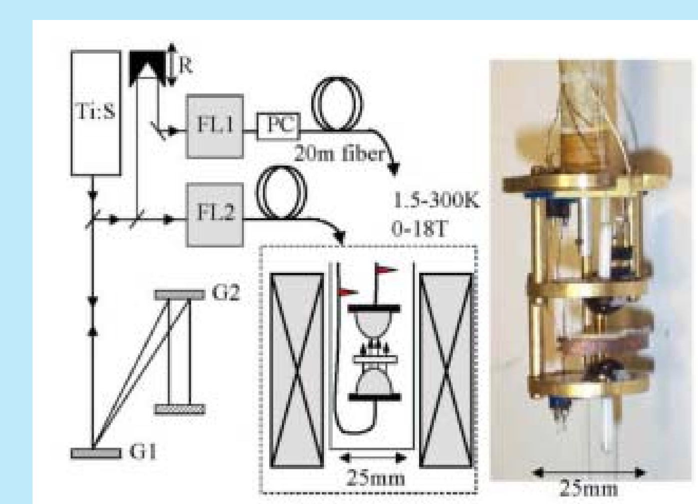

Figure 6: (a) Time-resolved photoluminescence (PL) decays from a dense film of nominally 12.4 A CdSe quantum dots at the energies specified in the inset. Inset: cw PL spectra from dense film (solid) and original solution (dashed), showing redshift. (b) Dynamic redshift of the PL peak, as excitons transfer from donor to acceptor dots. Inset: PL spectra at the specified times.

Fiber-coupled antennas for ultrafast coherent terahertz spectroscopy in low temperatures and high magnetic fields
S.A. Crooker et al. Rev. of Scientific Instruments, 73 (2002) 3258

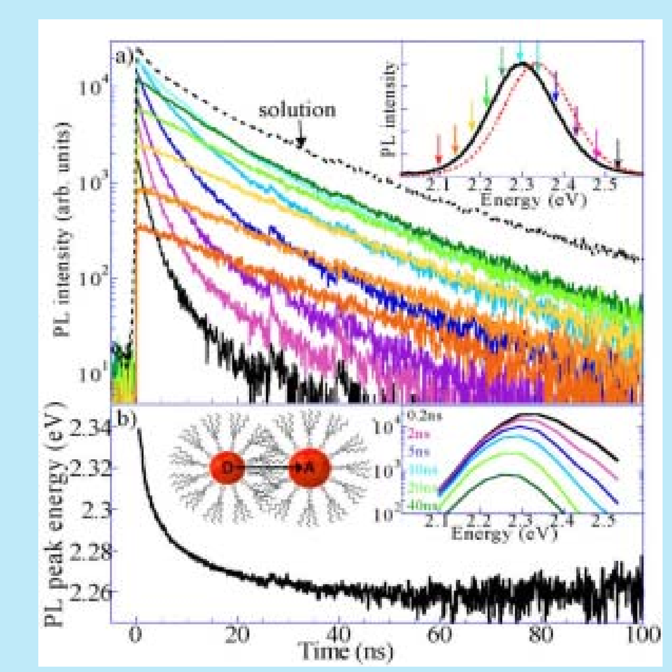

Figure 7: Schematic of the experiment (left) and photograph of the low-temperature, high-field THz probe (right). The THz emitter and receiver face each other in the bore of the magnet, and the sample may be positioned in between. Single-mode optical fibers couple the shaped excitation and gating ultrafast optical pulses to the antennas.

Spectrally Resolved Dynamic of Energy Transfer in Quantum-Dot Assemblies: Towards Engineered Energy Flows in Artificial Materials
*S. A. Crooker et al., Physical Review Letters **89** (2002) 186802*